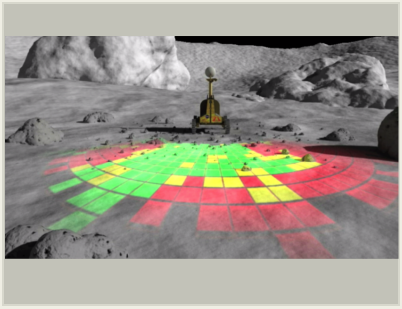
Long-Range Terrain Characterization for Productive Regolith Excavation, Phase I

Completed Technology Project (2015 - 2016)

Project Introduction

The proposed research will develop long-range terrain characterization technologies for autonomous excavation in planetary environments. This work will develop a machine learning framework for long-range prediction of both surface and subsurface terrain characteristics that: (1) indicate the excavation-value of the material and (2) describe how hazardous terrain is to a robotic excavator. Factors influencing importance include the mineral composition of the material and the presence and concentration of volatiles. Terrain hazards will include loose terrain that could cause wheels to sink or slip as well as the presence of surface and subsurface rocks that would inhibit excavation. This work will develop technologies for long-range terrain mechanical characterization and volatile prediction with high spatial coverage. Ground penetrating radars and neutron spectrometers provide reasonable accurate estimates of subsurface composition and volatile accumulation; however, they are limited in sampling range and area. Cameras and LIDAR will instead be used to measure reflected radiation, temperature, and geometry at long range with a wide field of view. From these measurements, the thermal properties and spectral reflectance curves of the terrain will be estimated, since both are correlated to terrain composition and traversability. These properties, along with geometry, will be fed into a machine learning framework for prediction of terrain characteristics. Priors will be generated based on data from orbital satellites. Measurements of material composition, volatile accumulation, and traversability will be generated from expert labeling, neutron spectrometers, and wheel slip measurements, respectively. These measurements will be used to train machine learning algorithms for long-range prediction of terrain mechanical characteristics and resource concentration.



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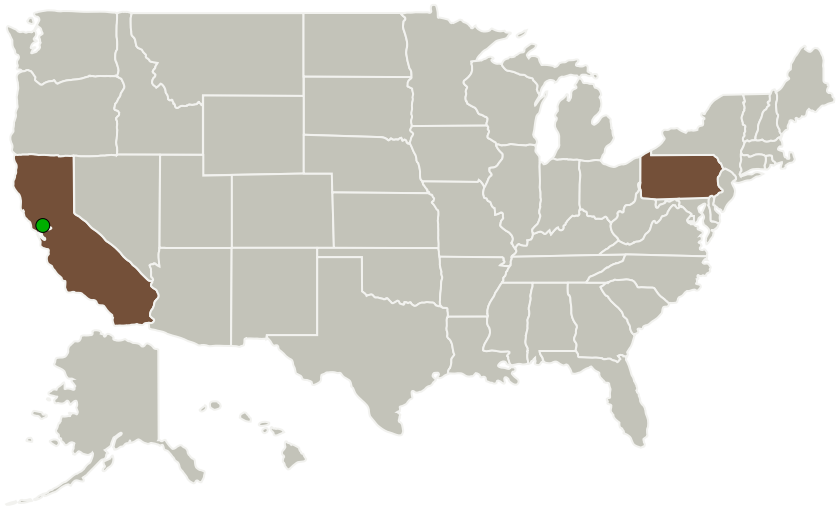
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Astrobotic Technology, Inc.	Lead Organization	Industry	Pittsburgh, Pennsylvania
Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California
Carnegie Mellon University	Supporting Organization	Academia	Pittsburgh, Pennsylvania

Primary U.S. Work Locations	
California	Pennsylvania

Project Transitions

June 2015: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Astrobotic Technology, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

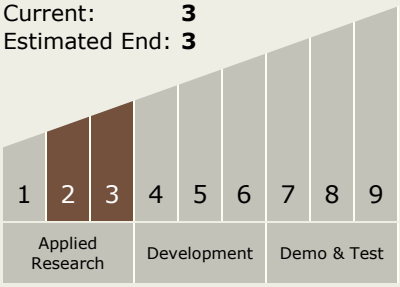
Carlos Torrez

Principal Investigator:

William Whittaker

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



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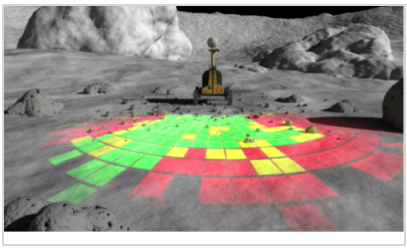
June 2016: Closed out

Closeout Summary: Long-range terrain characterization for productive regolith excavation, Phase I Project Image

Closeout Documentation:

- Final Summary Chart Image*(https://techport.nasa.gov/file/139164)*

Images



Briefing Chart Image
Long-range terrain characterization for productive regolith excavation, Phase I
(https://techport.nasa.gov/image/132092)

Technology Areas

Primary:

- TX04 Robotic Systems
  - TX04.1 Sensing and Perception
    - TX04.1.4 Object, Event, and Activity Recognition

Target Destinations

The Moon, Mars, Outside the Solar System, The Sun, Earth, Others Inside the Solar System